



● energy
> ● scenarios
● school

Szenario Modellierung am Beispiel DESERTEC

Franz Trieb

Research Days, Bad Boll, 28.02.2012

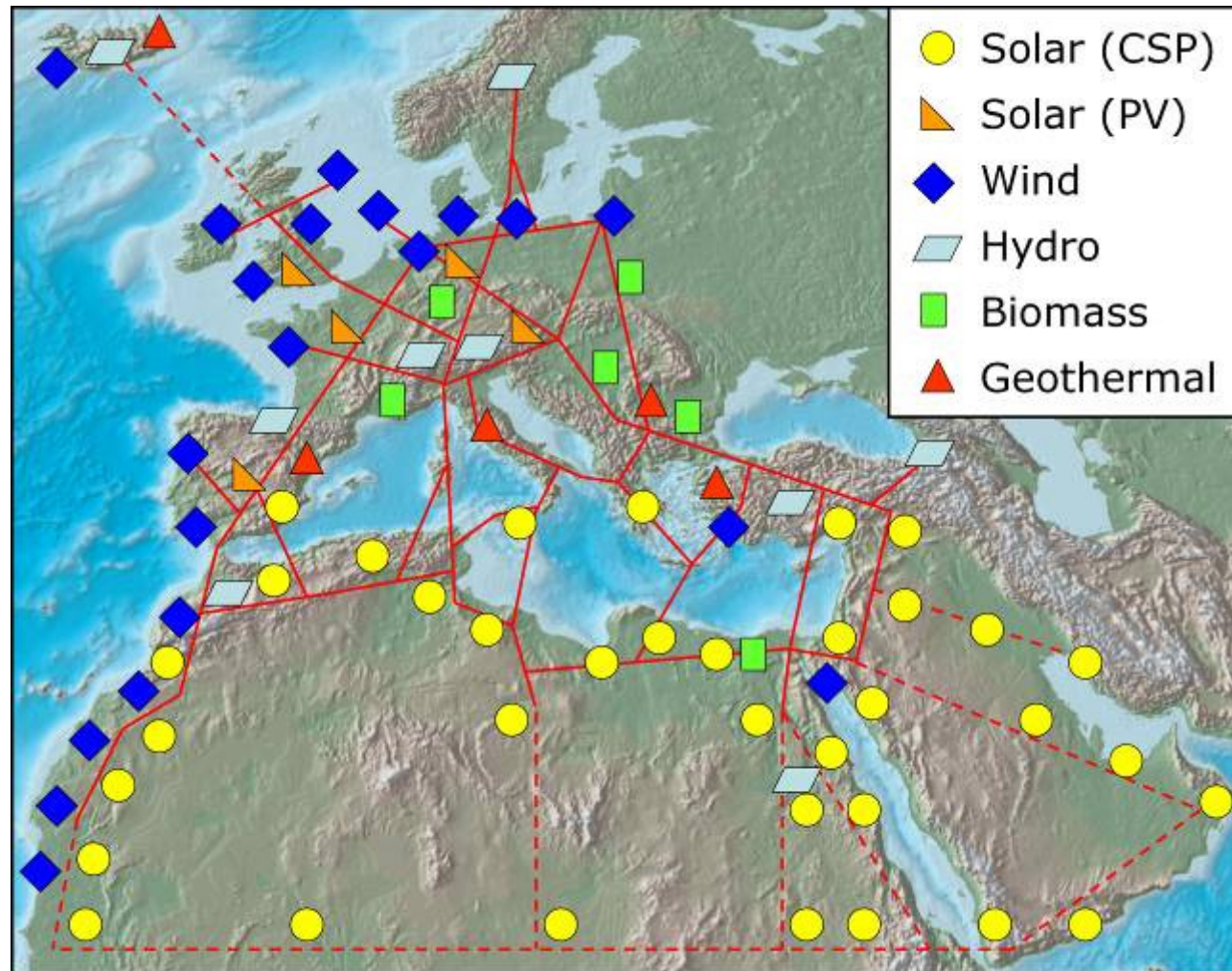
DESERTEC Vision: HGÜ-Stromautobahnen verbinden gute Produktionsstandorte mit großen Verbrauchszentren

TREC
Clean Power from the Deserts
Trans-Mediterranean
Renewable Energy Cooperation
In conjunction with The Club of Rome



DESERTEC
FOUNDATION

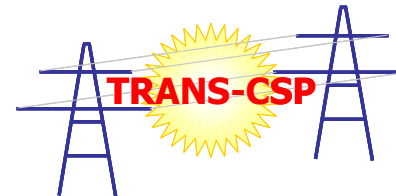
 **Deutsches Zentrum
für Luft- und Raumfahrt e.V.**
in der Helmholtz-Gemeinschaft



<http://www.desertec.org>



Studien



Ermittlung der erneuerbaren Energiepotentiale für die nachhaltige Produktion von Elektrizität und Trinkwasser in 50 Ländern Europas, Nordafrikas und des Mittleren Ostens unter Berücksichtigung der Option solarthermischer Kraftwerke.



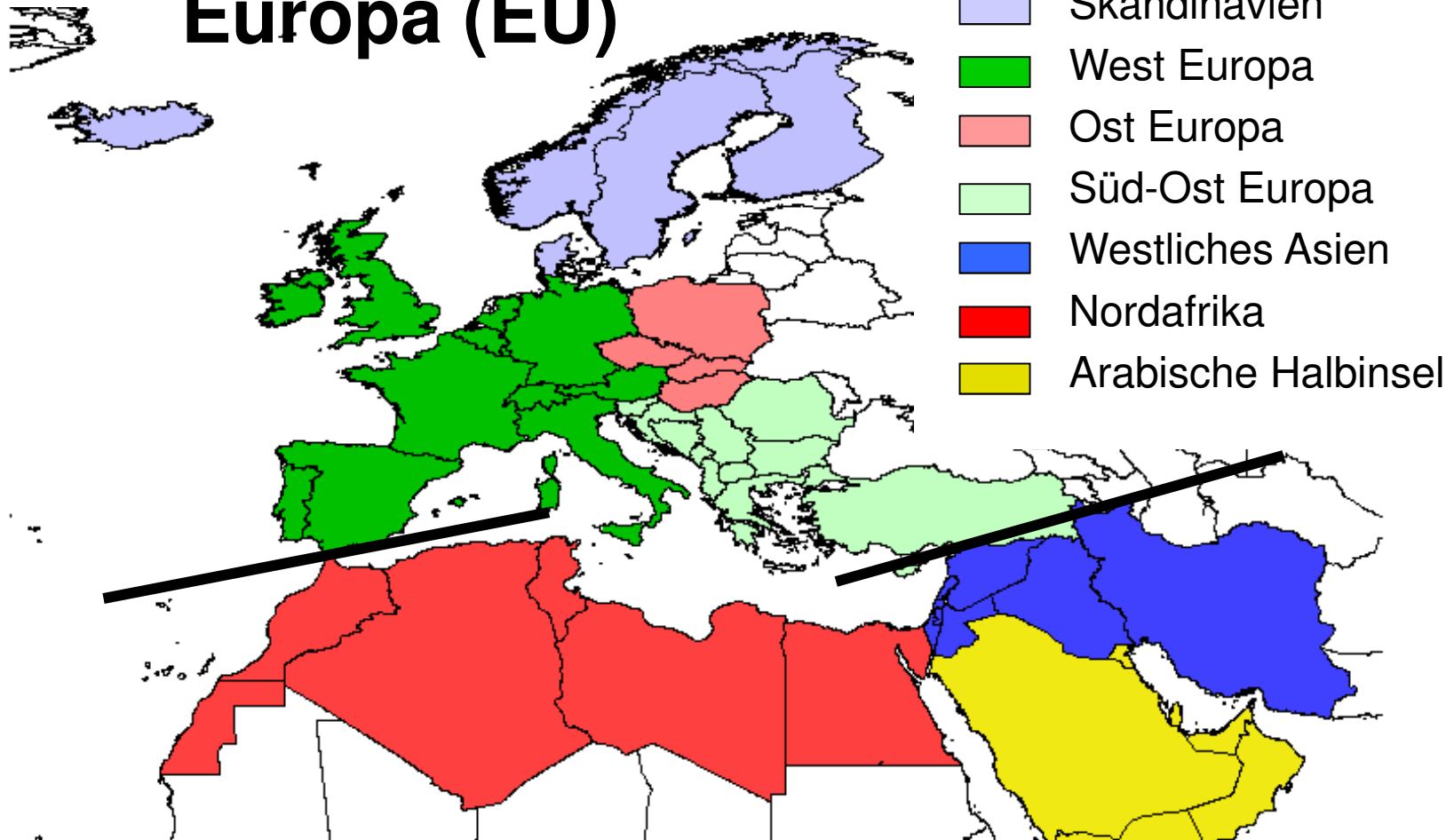
Bundesministerium
für Umwelt, Naturschutz
und Reaktorsicherheit



Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Insgesamt 50 Länder untersucht

Europa (EU)



Middle East & North Africa (MENA)



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in der Helmholtz-Gemeinschaft

www.dlr.de/tt/trans-csp

Folie 4



Nachfragemodelle



DLR

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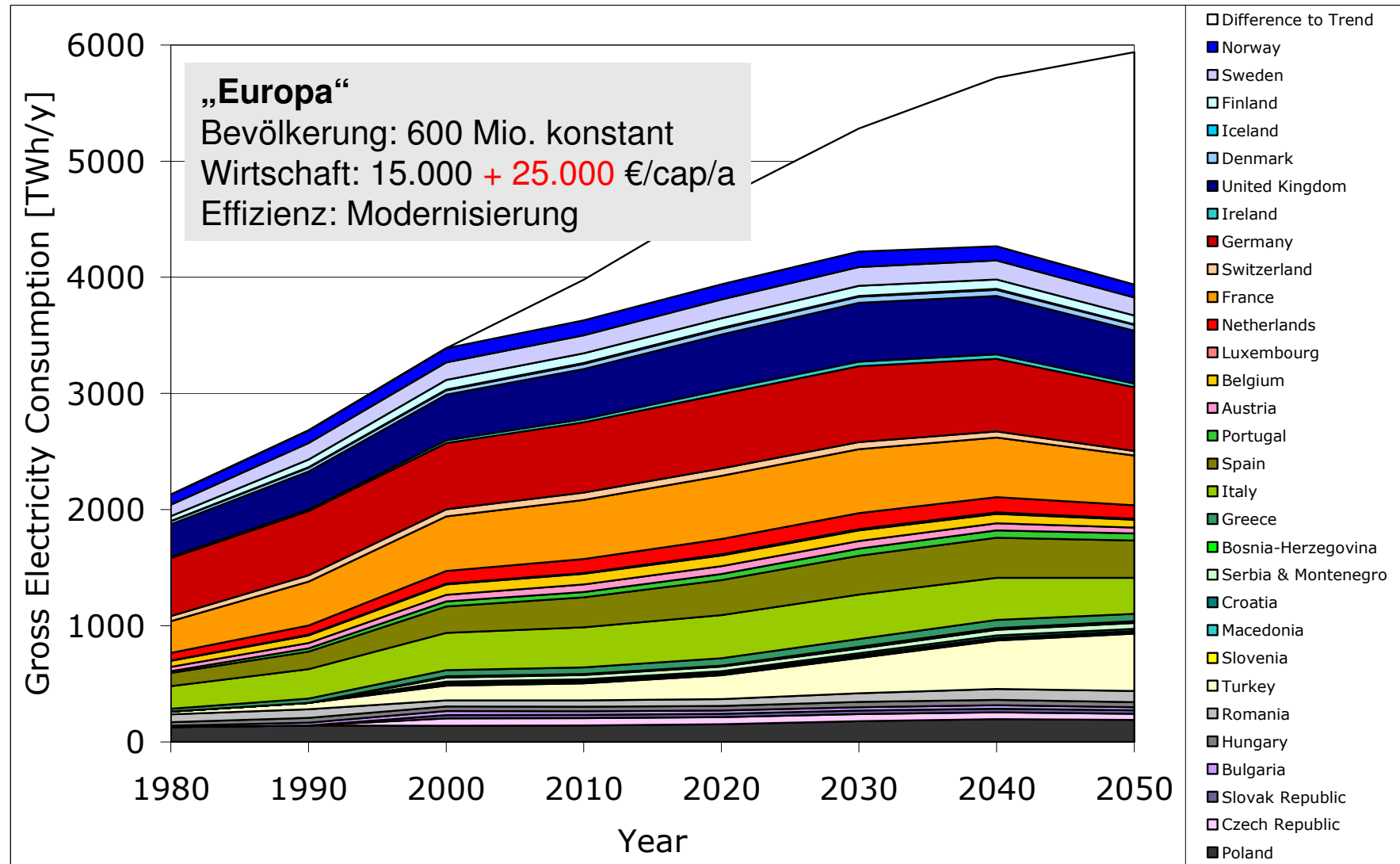
Folie 5



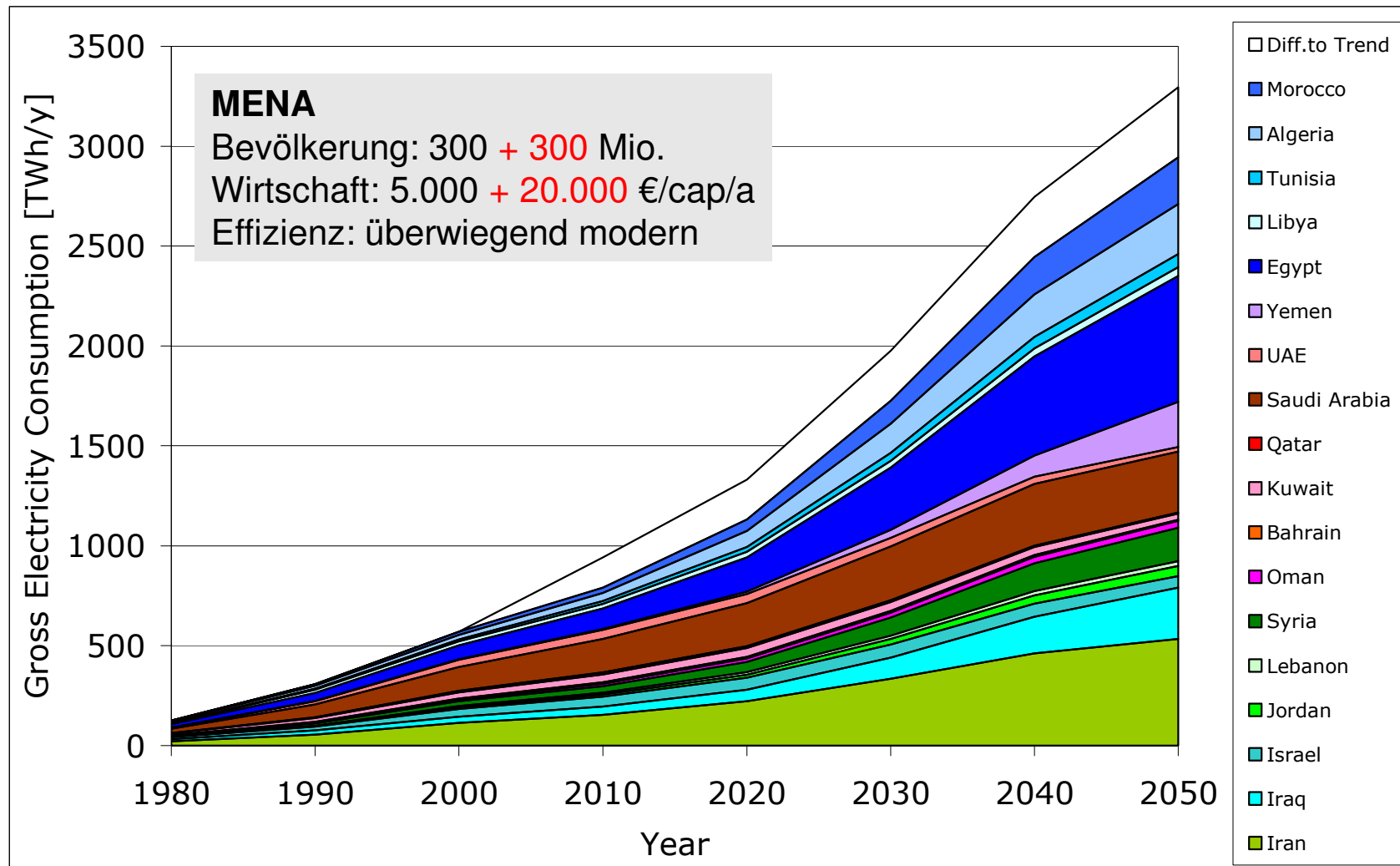
Ermittlung der Nachfragepotenziale

- Historische und aktuelle Nachfrage
 - Historisches und zukünftiges Bevölkerungswachstum
 - Historisches und zukünftiges Wirtschaftswachstum
 - Historische und zukünftige Korrelation von Wirtschaft, Bevölkerung und Energiebedarf (Grad der Entkopplung – Effizienzpotenziale)
- ➔ voraussichtliche Entwicklung des Energiebedarfs
(unter den jeweils getroffenen Annahmen)

TRANS-CSP: Strombedarf in „Europa“ (ohne Elektromobilität)



MED-CSP: Strombedarf im Mittleren Osten und Nordafrika (MENA)





Technologieoptionen und Angebotspotenziale



Portfolio technischer Möglichkeiten (z.B. Strom)

✓ Effizienz

- ✓ Kohle, Braunkohle
- ✓ Erdöl, Erdgas
- ✓ Kernspaltung, Kernfusion
- ✓ Wasserkraft
- ✓ Biomasse
- ✓ Solarthermische Kraftwerke
- ✓ Geothermie (Hot Dry Rock)
- ✓ Windenergie
- ✓ Photovoltaik
- ✓ Wellen / Gezeiten

...
ideal gespeicherte
Energieträger

...
speicherbare
Energieträger

...
fluktuierende
Energieträger

➔ unterschiedliche Rollen im zukünftigen Energiemix

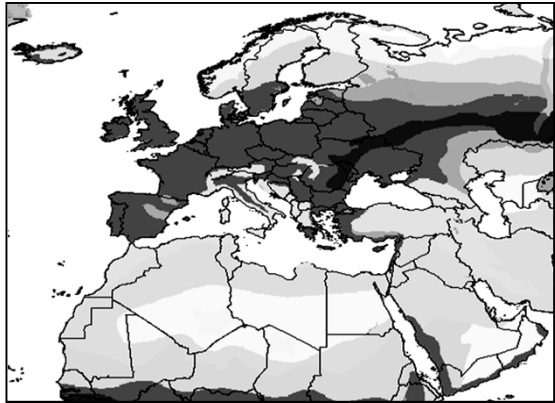


Ermittlung der Angebotspotenziale

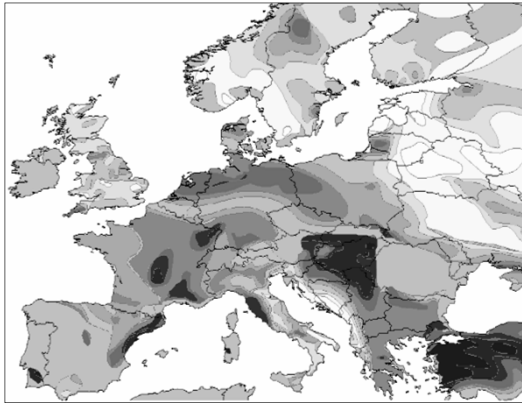
- Räumliche Verteilung der Ressourcen
 - Zeitliche Schwankungen des Angebots, Ausgleichseffekte
 - Flächenausbeute, Landbedarf
 - Ausschlussflächen
 - Technische und wirtschaftliche Potenziale
- ➔ Potenzielle Anteile im zukünftigen Energiemix

Erneuerbare Energiepotenziale in Europa, Mittlerer Osten, Nordafrika

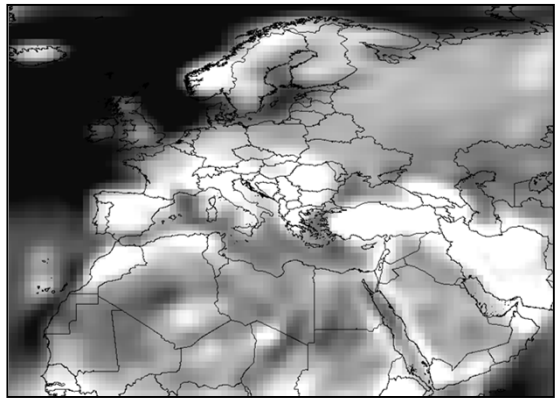
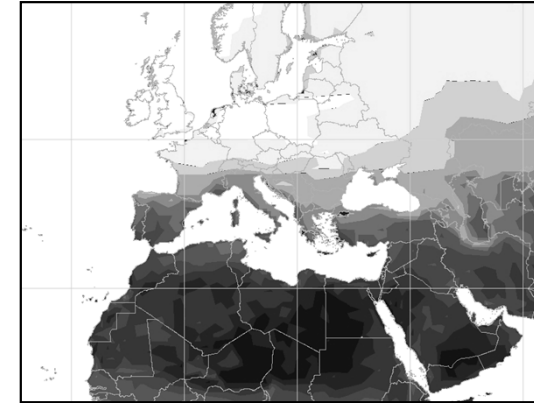
Biomasse (0-1)



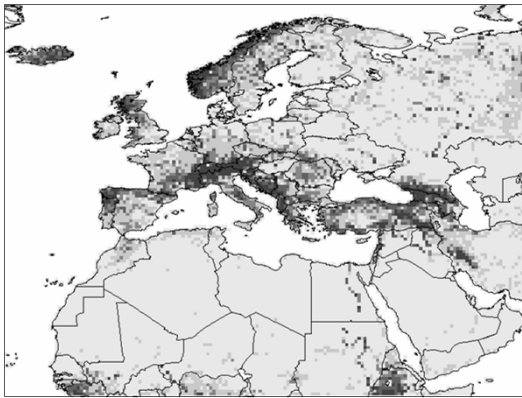
Geothermie (0-1)



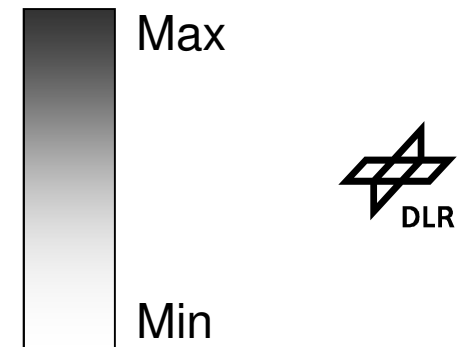
Solar (10-250)



Windkraft (5-50)



Wasserkraft (0-50)



Stromertrag
in GWh/km²/a



Zielfunktion und Leitplanken

Es kommt nicht darauf an, die Zukunft vorauszusagen,
sondern darauf, auf die Zukunft vorbereitet zu sein.

Perikles, (um 500 - 429 v. Chr.)



Definition einer Zielfunktion: z.B. Nachhaltigkeit

✓ **sicher**

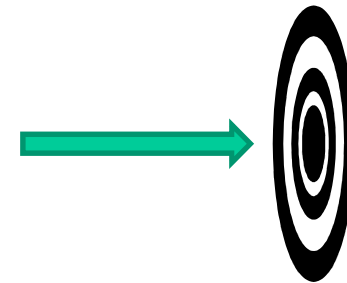
verschiedene, sich ergänzende Quellen und Reserven
Lastdeckung nach Bedarf
langfristig verfügbare Ressourcen
bereits sichtbare und zeitnah ausbaubare Technologie

✓ **kostengünstig**

niedrige Kosten
keine langfristigen Subventionen

✓ **umwelt- und sozial kompatibel**

geringe Emissionen
Klimaschutz
geringe Risiken
fairer Zugang





Beispiele für Leitplanken

✓ harte Leitplanken

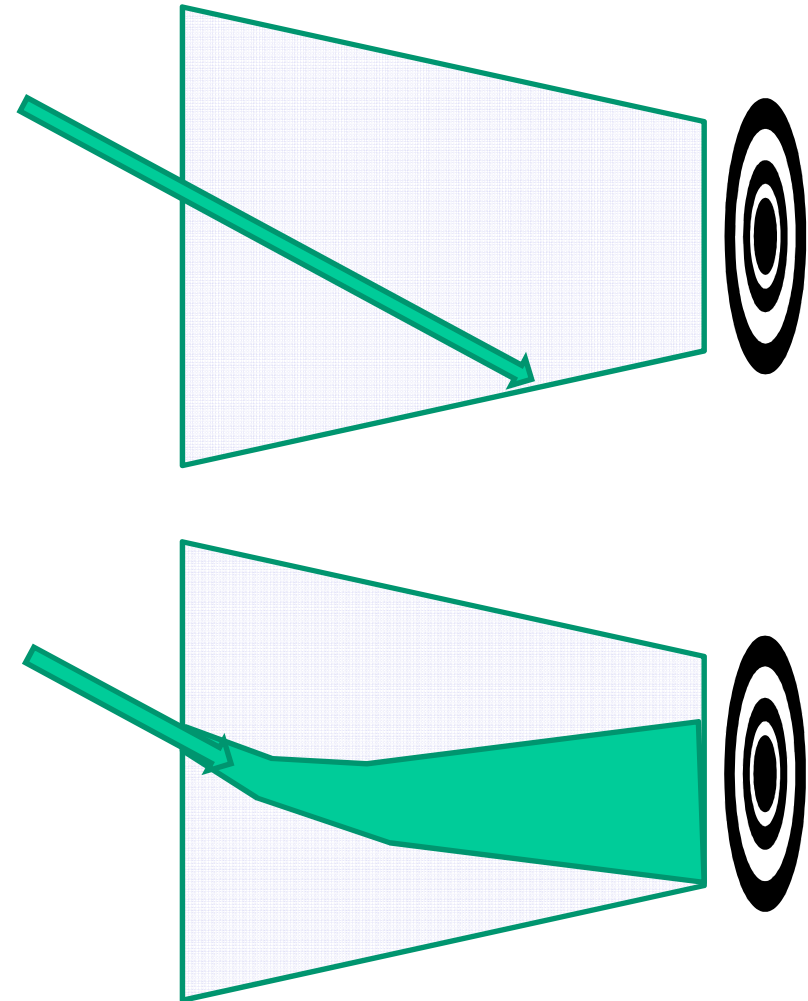
Ressourcenpotenziale
Ressourcenverfügbarkeit
Umweltverträglichkeit
Versorgungssicherheit

...

✓ veränderliche Leitplanken

Energiepolitik
Tarifstruktur
Konkurrenzfähigkeit
Technologieoptionen

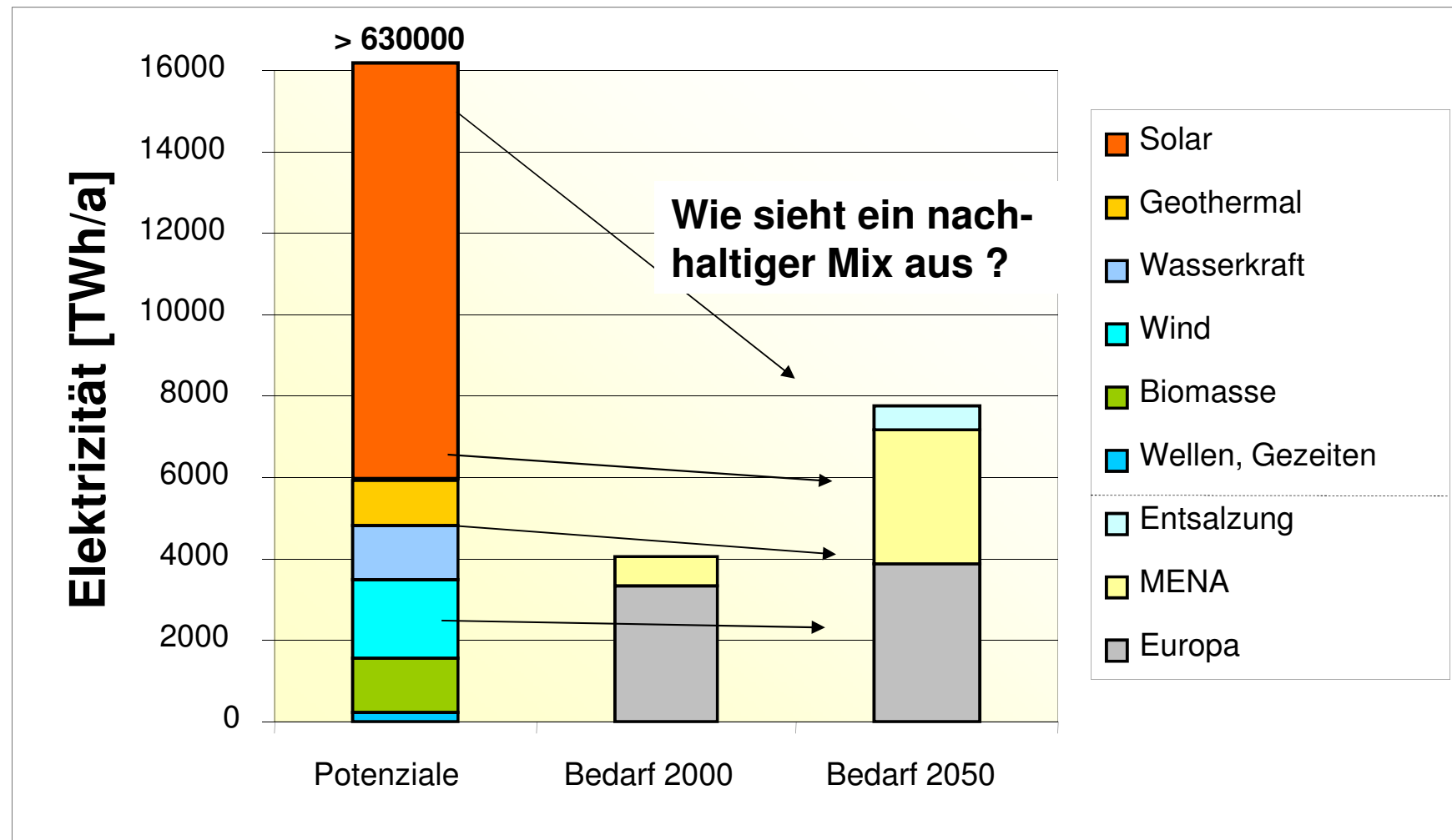
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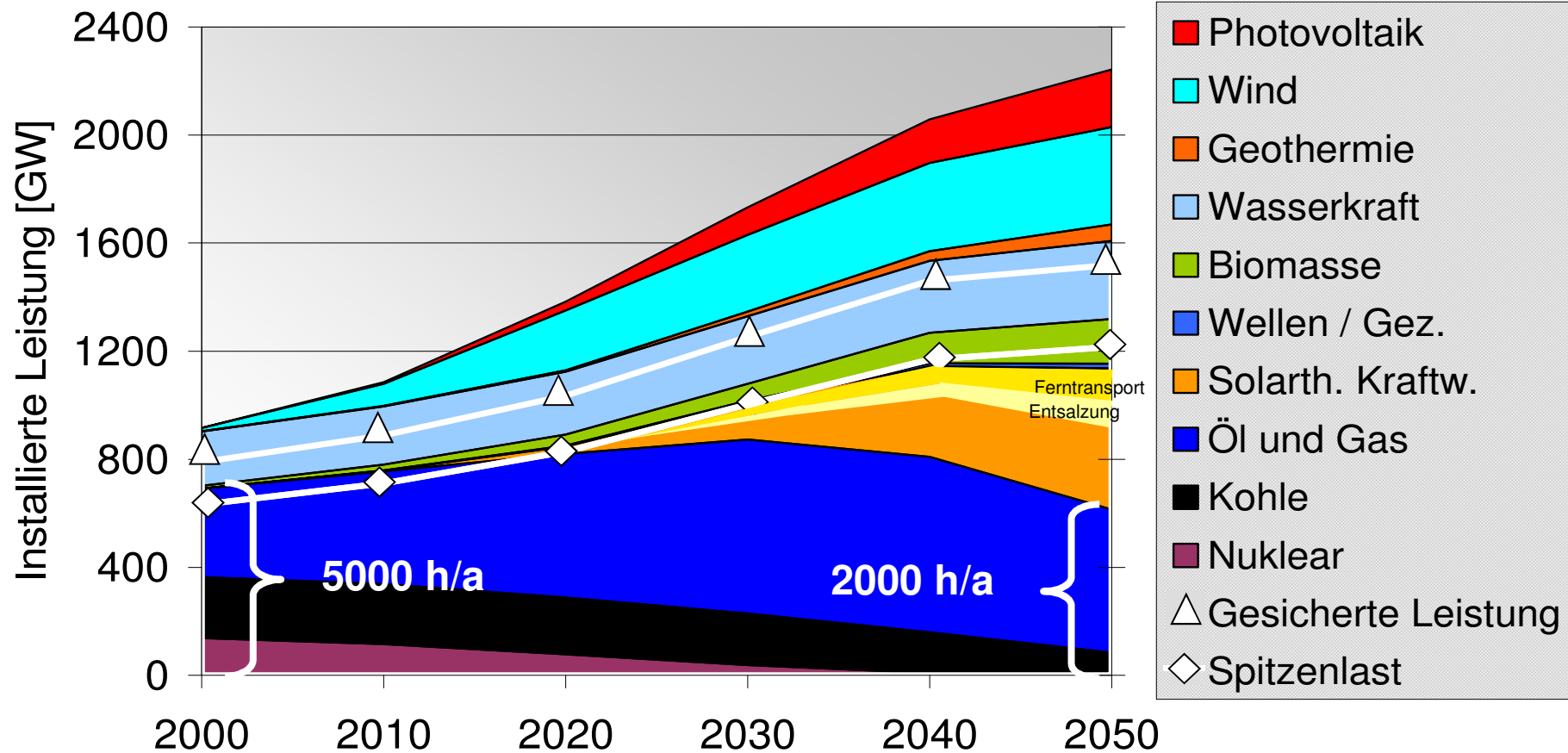
Versorgungsmodelle, Auswirkungen und Schlussfolgerungen

Ökonomische Potenziale vs. Bedarf in EU-MENA





Installierte Leistung und Spitzenlast in EUMENA



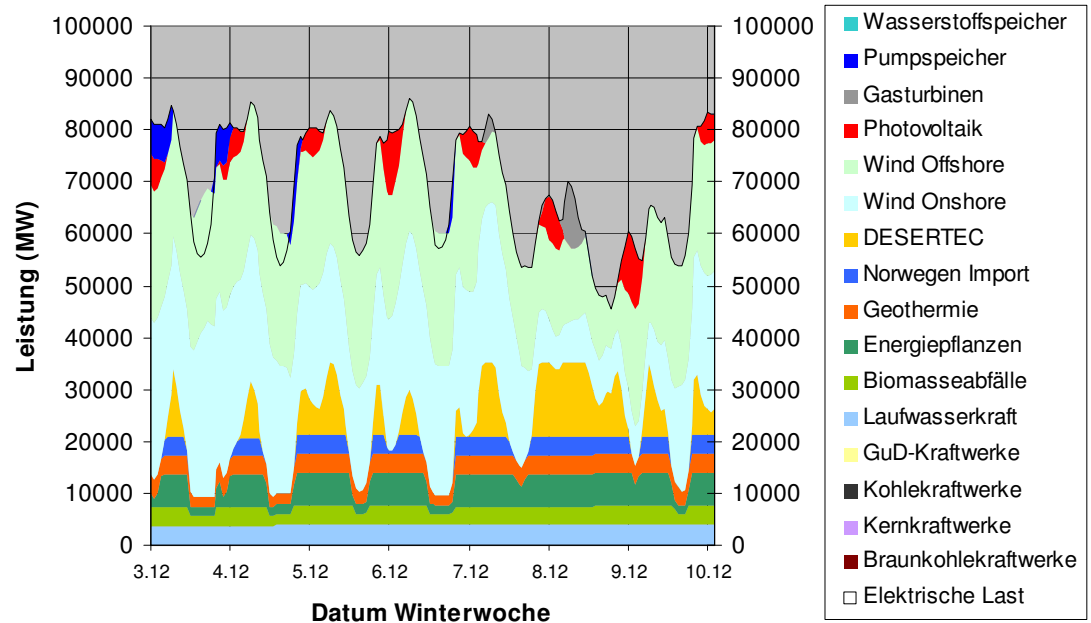
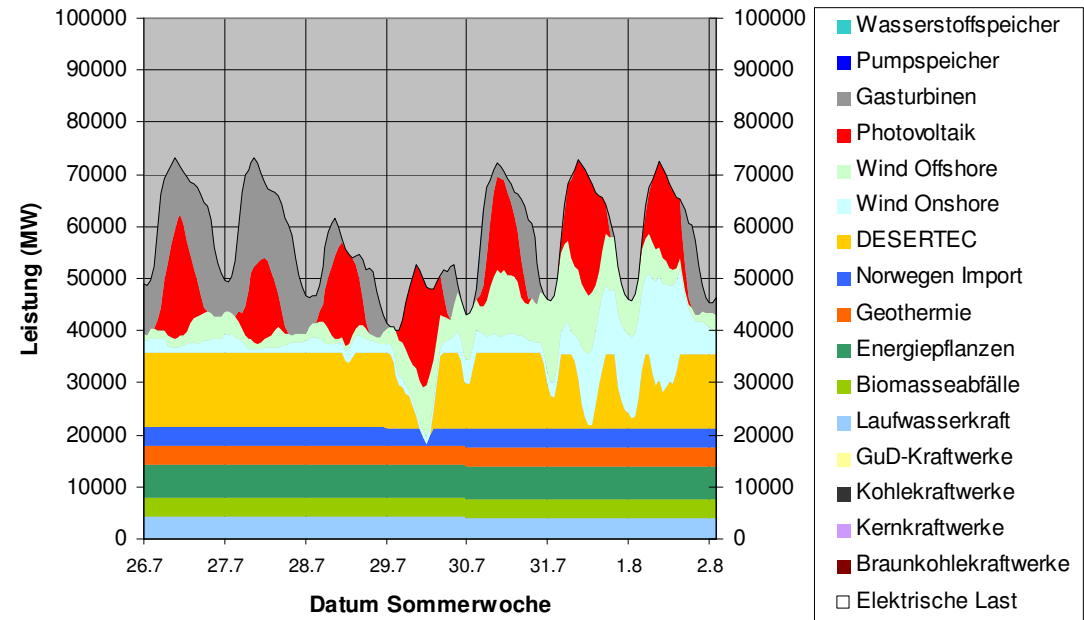
→ 100 % Verfügbarkeit + 25 % Reservekapazität

Deutschland 2050

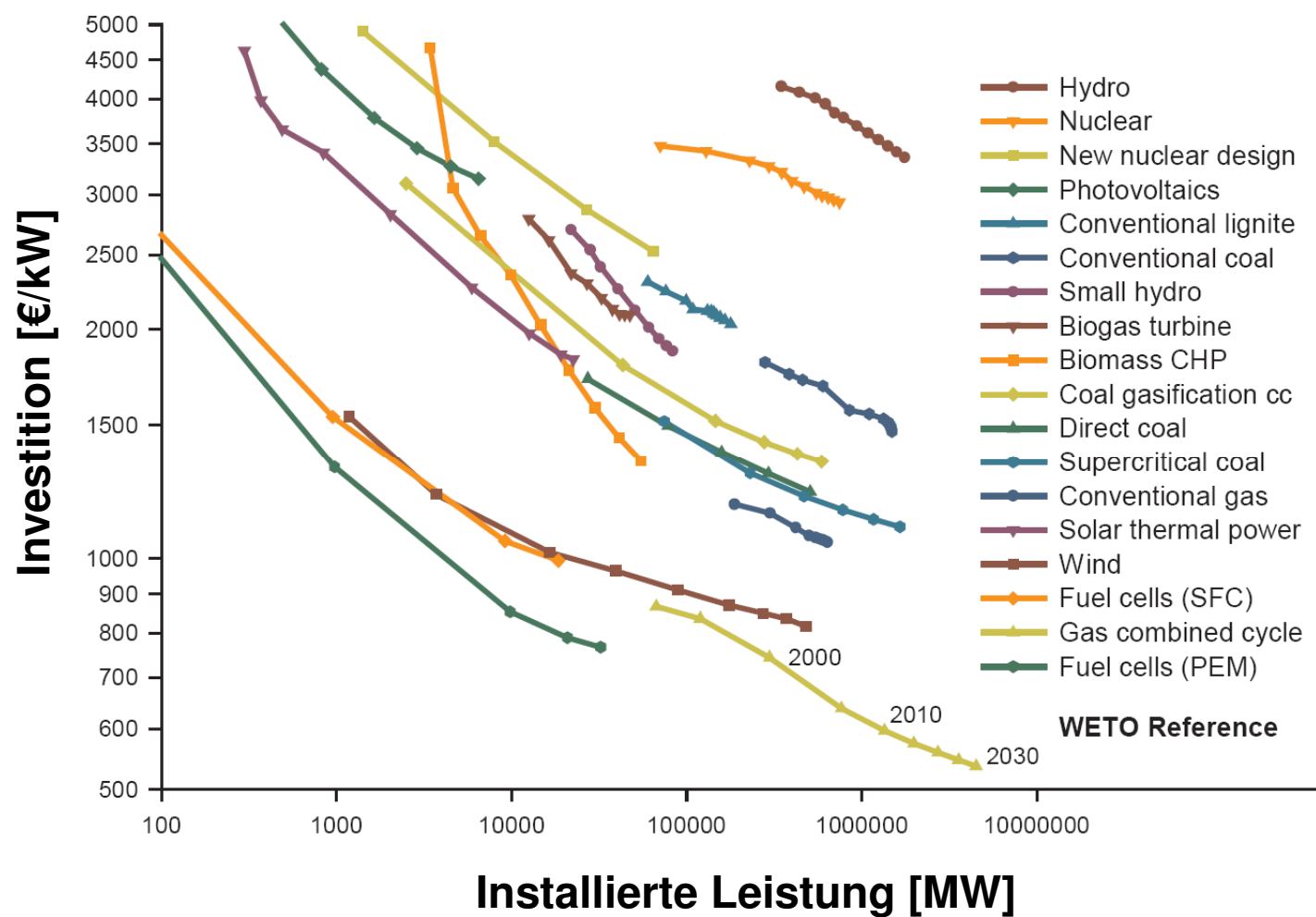
Die Rolle variabler und flexibler Energiequellen in einem 90% EE Szenario.

Installierte Leistung:

| | | |
|-------------------|-------|---------------|
| Photovoltaik: | 45 GW | } var. EE |
| Wind Onshore: | 40 GW | |
| Wind Offshore: | 27 GW | |
| Laufwasserkraft : | 6 GW | } flex. EE |
| DESERTEC: | 16 GW | |
| Import Norwegen | 4 GW | |
| Geothermie: | 4 GW | } flex. konv. |
| Biomasse: | 7 GW | |
| Abfälle: | 4 GW | |
| Erdgas: | 63 GW | |



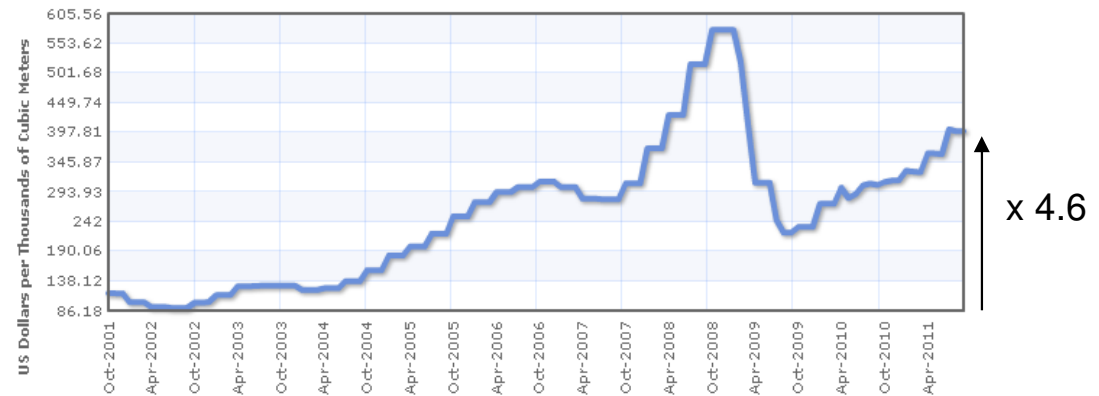
Kraftwerkspreise sinken mit steigender Kapazität



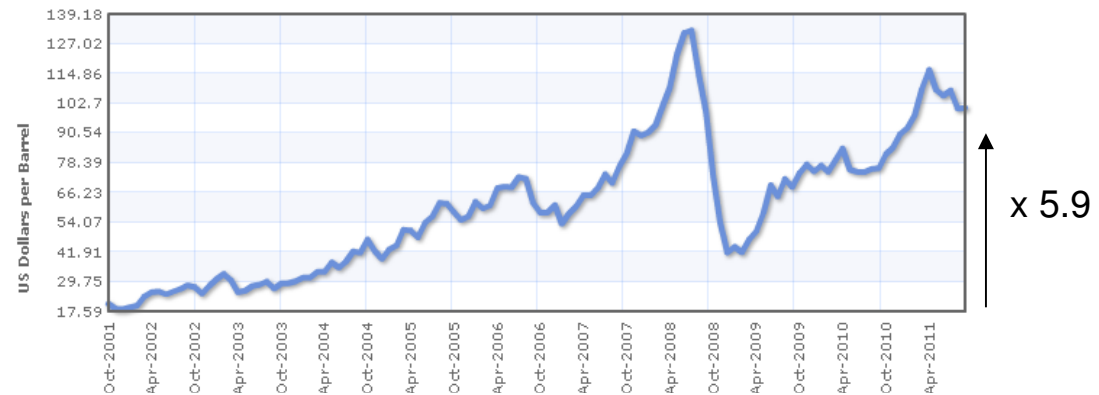


Brennstoffpreise 2001-2011:

Erdgas
Russland



Rohöl

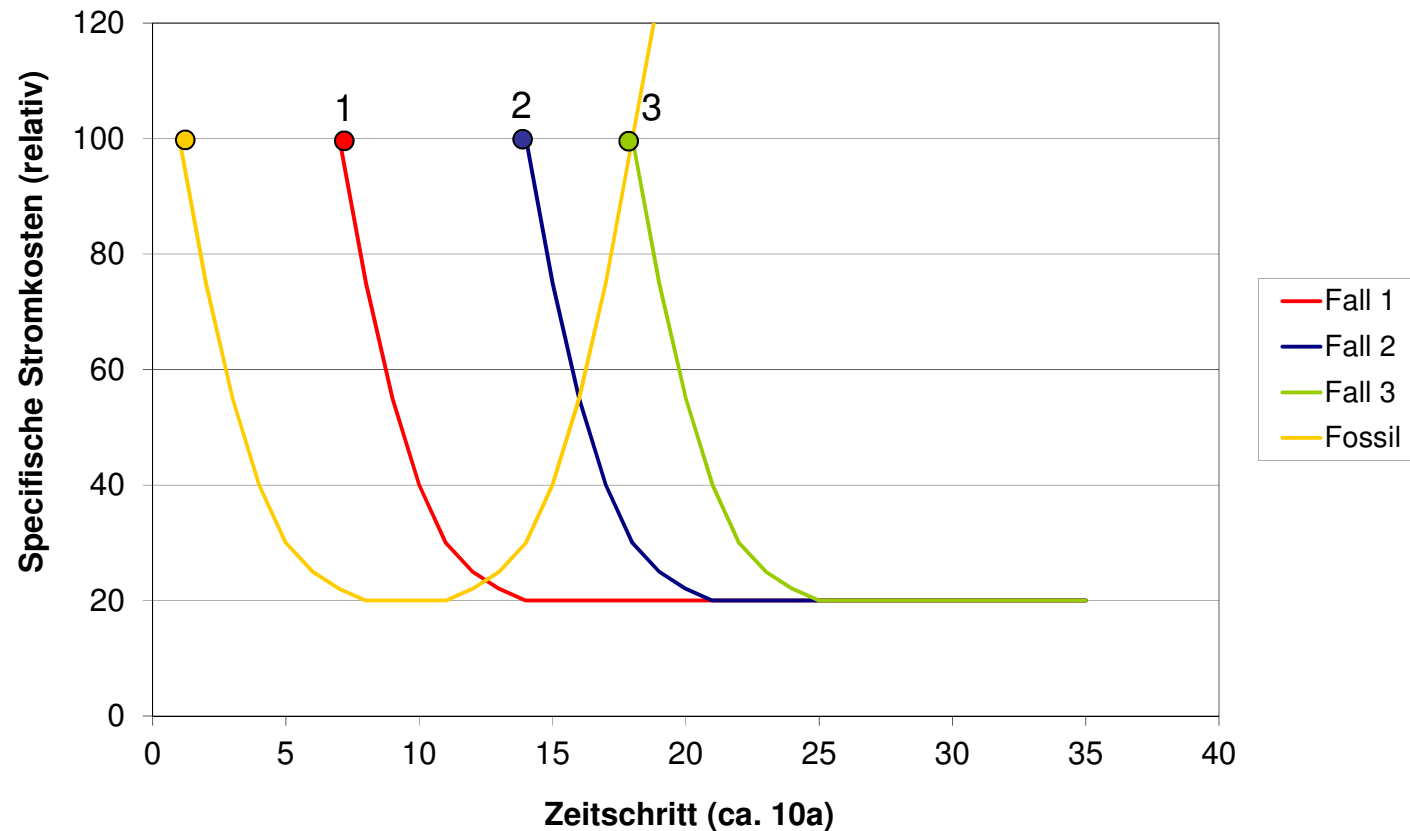


Kraftwerkskohle
Australien





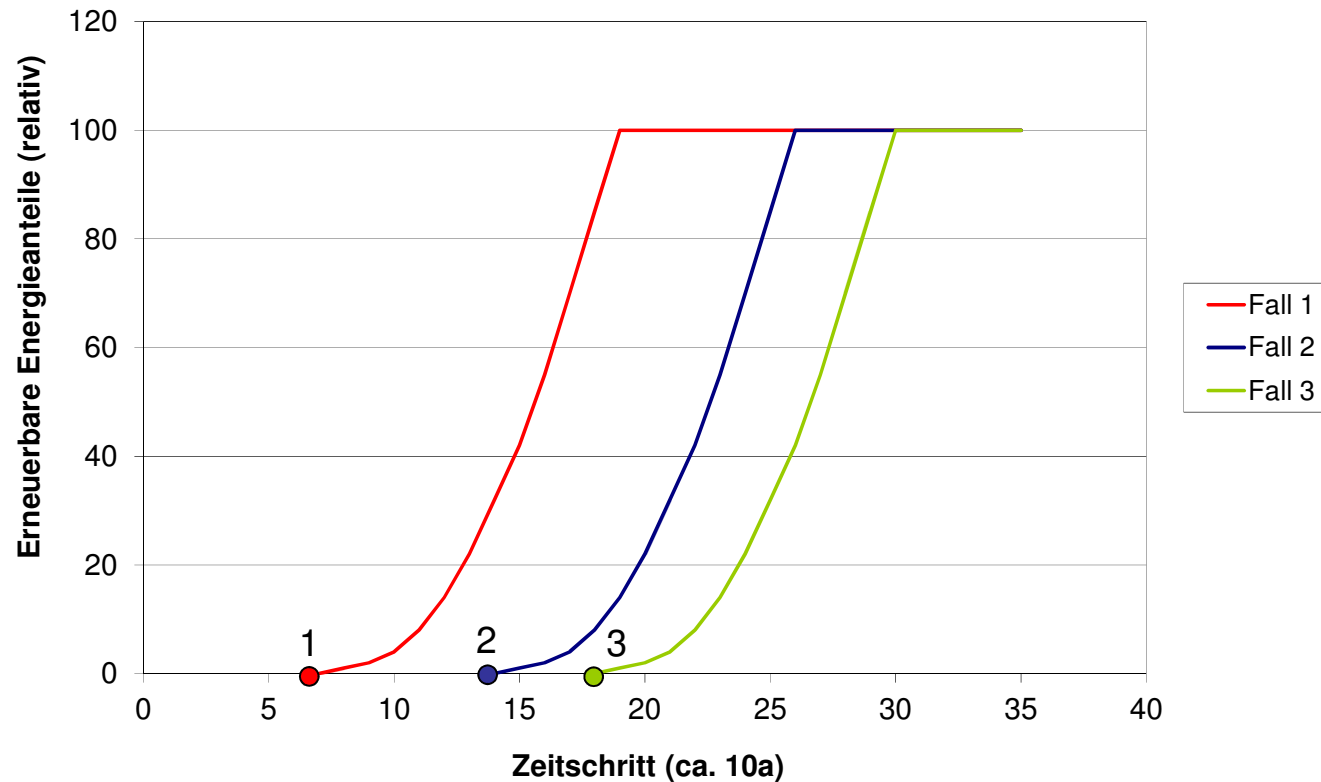
Der beste Zeitpunkt für EE Investitionen ist ...?



1. Sobald die EE Technologie verfügbar ist?
2. Wenn Brennstoffpreise über EE Basiskosten ansteigen?
3. Wenn EE konkurrenzfähig sind?

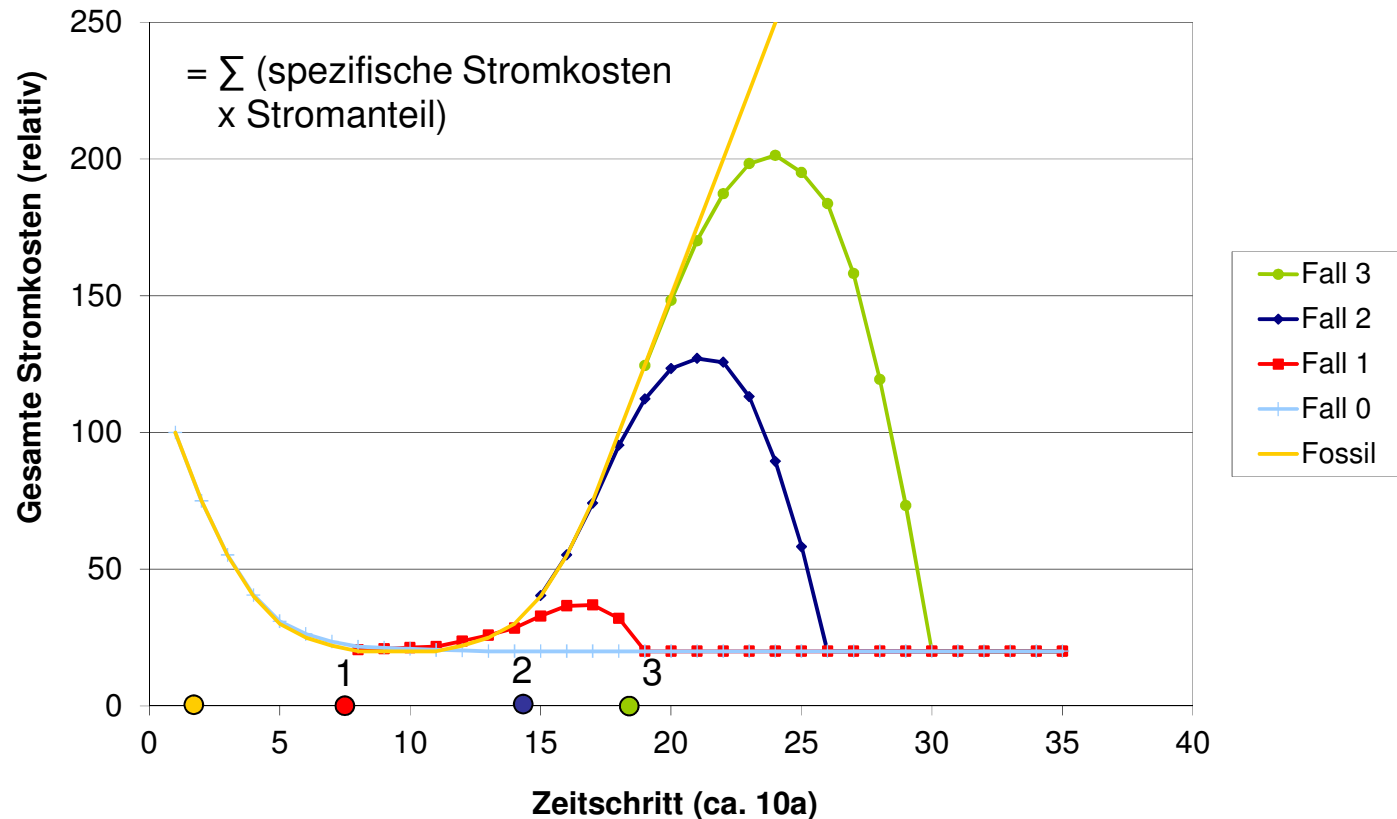


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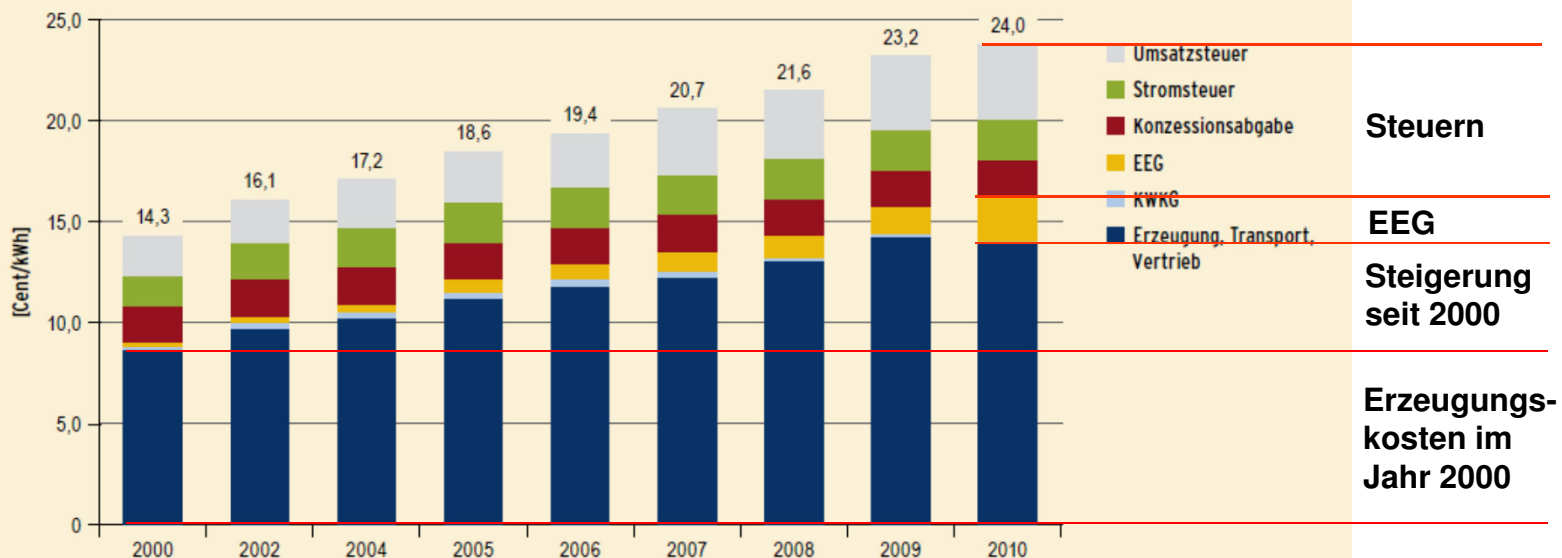
Der beste Zeitpunkt für EE Investitionen ist ...?



1. **Sobald die EE Technologie verfügbar ist!!**
2. ~~Wenn Brennstoffpreise über EE Basiskosten ansteigen?~~
3. ~~Wenn EE konkurrenzfähig sind?~~

Das EEG: Kosten pro kWh für Haushaltskunden in Deutschland

Kostenanteile für eine Kilowattstunde Strom für Haushaltskunden






Robuste Szenarien (im Sinne von Perikles)

1. Nachhaltigkeit als Zielfunktion
2. Qualität und Stabilität als Weg
3. Leitplanken als Orientierung
4. Kurzfristige Trends und langfristige Wirkungen
5. Konsistenz
6. Bezahlbare Transformationskosten
7. Zielgerichtete Instrumente und Rahmenbedingungen





**Concentrating Solar Power
for the
Mediterranean Region**



Final Report


by

German Aerospace Center (DLR)
Institute of Technical Thermodynamics
Section Systems Analysis and Technology Assessment

Study commissioned by

Federal Ministry for the Environment,
Nature Conservation and Nuclear Safety
Germany



**Trans-Mediterranean
Interconnection for
Concentrating Solar Power**



Final Report


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Germany



**Concentrating Solar Power
for Seawater Desalination**



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Financing concentrating solar power in the Middle East and North Africa—Subsidy or investment?

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Renewable energy finance
Middle East and North Africa

1. Introduction

To date, Spain and the United States are the only market places for concentrating solar power (CSP) with active supply channels. CSP project development is also taking place in India, North Africa, UAE, Morocco, Jordan and other countries. Although the Middle East and North Africa (MENA) have abundant reserves in solar energy, CSP is still not used except for some minor demonstration plants. Main barriers are the large initial investment and the inefficiency of the MENA electricity sector. Public utilities are reluctant to charge higher electricity tariffs from their customers, and thus follow mainly a business as usual approach, in many cases even making losses on conventional electricity tariffs.

However, credit oil prices peaking at 140\$/barrel in summer 2008 have shown that this strategy may be rather risky and may quickly change into a crisis, hindering energy consumers much more than the introduction of renewable energy. Therefore,

several MENA countries have recently changed towards CSP, and are now starting with first costs and provide some initial markets. However, has not yet been defined. Calling for least cost subsidies from international donor institutions to reduce costs and risks to an acceptable level, successful market introduction of concentrated solar power (CSP) must be designed specifically to match the needs (Commission of the European Communities).

2. Needs of MENA utilities

Like any other country, countries in the Middle East need an electricity supply structure that is secure and compatible with society and the environment. Sustainable. Many public power utilities are obliged by their national laws to provide least cost electricity to their customers. That is one of the main reasons why they have been reluctant to accept CSP. The establishment of the DESERTEC Foundation in 2009 has provided a first step in the production of solar electricity in the Middle East and North Africa (MENA) for export to Europe (DeserTEC, 2009). In the meantime, industrial interest in the CSP and Med-CSP have started to develop a first strategic business plan for the last quarter of 2011 (Trieb et al., 2010). The study shows that solar electricity imports from concentrating solar power (CSP) produced within MENA and buffered by local thermal energy storage can provide renewable base load and balancing power that is highly needed for a sustainable European electricity mix, because European renewable sources like wind and photovoltaic power are mainly of fluctuating character (DeserTEC Foundation, 2011).

In the present paper we will characterize this scenario and the role of CSP imports for the future energy systems in Europe. We will give new and updated details on the quantification of solar import electricity and on the identification of import corridors from MENA to Europe.

2. Approach and methodology

This study is a result of updated and further developed analyses by the German Aerospace Center (DLR) based on ongoing and recently finished projects. The scenario for the long-term development of the European energy system and the assessment of the possible role, costs and environmental effects of CSP imports is based on the work done in cooperation with regional counterparts in the project TRANS-CSP document in detail in (Trieb et al., 2006). Within the REACT2050 project (Risk of Energy Availability: Common European for Europe Supply Security) long term potentials for solar electricity generation and the export from MENA countries were specified, and new detailed technical and cost data for electricity generation and power transmission options were compiled. In addition, the methodology of (Trieb, 2005)

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Solar electricity imports from the Middle East and North Africa to Europe

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Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

**Weiterentwicklung der
Ausbaustrategie Erneuerbare Energien
Leitstudie 2008**



| Reihe Umweltpolitik |

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A SUSTAINABLE WORLD ENERGY OUTLOOK



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